Site Need Statement

General Reference Information	
1 *	***Need Title*:** Fast Analytical Methods for Waste Processing
2 *	***Need Code:*** RL-WT122
3 *	***Need Summary*:** High-level waste (HLW) stored in underground tanks at a number of DOE facilities is or will be vitrified . The glass must satisfy the Waste Acceptance Product Specifications (WAPS) . One rate-limiting step in the process is analyzing samples of the HLW feed to determine the required glass formers, additives, and– composition so the expected glass will satisfy the WAPS. Analyses also show the products compliance with the WAPS according to the quality assurance provisions delineated in the Quality Assurance Requirements Document (QARD or RW-0333P). There are a number of approaches available for showing compliance including glass sampling and analysis (as performed at West Valley) and melter feed sampling and analysis (as performed at the Defense Waste Processing Facility, DWPF). Filling this need will aid the RPP-WTP project to optimize process control and compliance. Improved methods will reduce the analysis time for samples of the melter feed, reduce overall processing time, accelerate the vitrification process, and reduce costs If it becomes necessary to increase the throughput of the plant beyond the initial design capacity, feed qualification and monitoring technologies would limit the process. Faster analytical and monitoring methods are needed so that more rapid processing is an option.
4 *	***Origination Date*:** FY 20012 (November 15, 2001) (formerly RL-WT099-S, November 30, 2000)
5 *	***Need Type*:** Science Need
6	***Operation Office*:** Office of River Protection (ORP)
7	***Geographic Site Name*:** Hanford Site
8 *	***Project*:** Waste Treatment and Immobilization PlantOffice of River Protection - Treat Waste Balance of Mission ***PBS No:*** RLORP-TW067
9 *	***National Priority:*** ____1. High - Critical to the success of the EM program, and a solution is required to achieve the current planned cost and schedule. _X_2. Medium - Provides substantial benefit to EM program projects (e.g., moderate to high life-cycle cost savings or risk reduction, increased likelihood of compliance, increased assurance to avoid schedule delays). ____3. Low - Provides opportunities for significant, but lower cost savings or risk reduction, may reduce the uncertainty in EM program project success.
10	***Operations Office Priority*:**
Problem Description Information	
11	***Operations Office Program Description*:** To perform the activities necessary to remediate the Hanford tank waste, DOE assigned responsibility to the Office of River Protection (ORP) in Richland, Washington. DOE is has extendeding a contract for the design, construction, and commissioning of a new Waste Treatment and Immobilization Plant (WTP) that will treat and immobilize the waste for ultimate disposal. The WTP is comprised of four major elements, pretreatment, LAW immobilization, HLW immobilization, and balance of plant facilities. ORP is scheduled to award the contract in January 2001.
12	***Need/Problem Description*:** Chemical and radiochemical analysis of pretreated waste feeds (both HLW and LAW) on a batch-wise basis is currently planned to confirm compliance with product quality requirements prior to vitrification. This could be done by analyzing pretreated waste feeds and glass forming additives separately, or by sampling and analyzing the melter feed after blending with glass formers. Currently, analytical turnaround times for analysis of blended melter feed are too long (i.e. 24 – 40 hours or more) and could lead to a bottle-neck in feed processing rates. Rapid analysis methods are needed to determine the

	concentration of key chemical constituents that will be present in the glass at 0.5 wt% or greater, and radionuclides present at 0.05 % or more of total curies in the final waste form. Alternatively, a rapid analysis method could be used in conjunction with other waste characterization data by measuring key analytes on a batch-wise basis and correlating results to characterization data. Methods for rapid chemical and/or radiochemical analysis of blended melter feeds would also be useful for process control of the vitrification process. This could be accomplished by analyzing for a limited set of chemical constituents that are typically measured to characterize waste glasses. Currently, ICP-AES or ICP-MS is used to analyze 10 to 15 metals for this purpose. Either dissolved feed slurry samples or dissolved glass samples can be used for analysis. Methods to speed up, or eliminate sample dissolution would be one way to address this need. Accelerated vitrification is being considered, but could not take place without also accelerating the characterization process. On-line, or faster analyses would enable shorter process times, reducing costs by accelerating the overall vitrification process. In addition, better process control would reduce down time and improve process reliability.
13	***Functional Performance Requirements*:** Methods are needed to significantly reduce sample turnaround time to less than 10 hours per analysis. The methods should be capable of measuring analytes that would be present in the feed material and glass at the levels described in the Waste Acceptance Product Specifications for High-Level Waste (WAPS) . Process control methods are also needed. These require analyzing for a subset of components to provide confidence that acceptable glass would be produced in accordance with the RPP-WTP Project strategy for compliance with waste form requirements. The most current description of compliance strategies for ILAW and IHLW can be found in the RPP-WTP Products and Secondary Wastes Plan (PSWP) for ILAW and the Waste Form Compliance Plan for IHLW (WCP). For either purpose, the methods must be capable of providing data, with high confidence of the composition of the melter feed and the glass products.
14	***Definition of Solution*:** This task should result in methods that will significantly reduce analysis times (e.g. > 2-fold) such that overall waste processing is accelerated. New proposed technologies might include, but are not limited to faster analytical chemistry methods, faster analysis strategies, sensors, or inferential methods (physical monitoring methods which accurately characterize key waste stream parameters).
15 *	***Targeted Focus Area*:** Tanks Focus Area (TFA)
16	***Potential Benefits*:** Solution of this need will reduce the sample analysis time, support other activities for increasing throughput, and enhance process control of the LAW / HLW vitrification facilities.
17 *	***Potential Cost Savings*:** Savings could be greater than $1 billion dollars when deployed to enable increased waste treatment plant throughput.
18 *	***Potential Cost Savings Narrative*:** Cost savings will be realized during operations. Improved sample analysis times will reduce processing delays and/or delays in re-adjustment of melter feed batches. For a project that estimates a 20-50-billion dollar life cycle operating budget, the potential savings for rapid analyses are in the billions of dollars. Seeking to increase WTP throughput beyond the initial design capacity will also shorten the mission resulting in significant cost savings
	***Technical Basis*:** The HLW melter feed will be a chemically and physically complex slurry. Other DOE facilities that process similar wastes (West Valley and DWPF) apply relatively old technology and are a smaller scale to that expected on the RPP-WTP. DWPF has experienced delays in vitrification production due to the turn-around time required for melter feed sample acquisition and analysis.
19	***Cultural/Stakeholder Basis*:** The River Protection Project is committed to moving forward to design, construct, and put into operation the Waste Treatment and Immobilization Plant on the schedule recently agreed to in the Tri-Party Agreement. A robust program is necessary to ensure that delays, all of which are costly, are minimized. A key part of this risk mitigation is to include in the total program a capability to test with actual wastes the processes and equipment planned, or later in use.

20	***Environment, Safety, and Health Basis*:** An optimal melter feed system design will minimize the inventory of melter feed while providing adequate hold-up to ensure tank contents are homogeneous. Optimization of the number and size of samples is also advantageous from a safety viewpoint. Statistically proven demonstration that a compliant glass product will be generated will provide confidence to regulators and facilitate their acceptance of the proposed compliance strategy.
21	***Regulatory Drivers*:** HLW product compliance strategy acceptance by DOE-RW. Meet TPA schedule for HLW immobilization. Environmental Impact Statement (EIS) for the Tank Waste Remediation System (TWRS) (DOE-RL and Ecology 1996) and the Hanford Federal Facility Agreement and Consent Order (known as the Tri-Party Agreement) and its amendments. DOE has negotiated additions to the Tri-Party Agreement that require the retrieval of single shell tanks by 2018, and the startup and operation of the WTP to support the treatment and immobilization of tank waste. By operating the WTP not only is that capability demonstrated and about 10% by volume (25% by activity) of the tank waste processed, but space is made available in the double shell tanks to allow the single shell tank retrieval to proceed without the expenditure of vast sums for additional double shell tanks. Other regulatory drivers include gathering the data necessary for the regulatory permits required for the startup and operation of the facility.
22 *	***Milestones*:** November 15, 1999 Tri-Party Agreement: • Start (Hot) commissioning-Phase I Treatment Complex 12/2007 • Start Operation-Phase 1 Treatment Complex 12/2009 • Complete Phase I-Treatment (no less than 10% of the tank waste by volume and 25% of the tank waste by activity) 12/2018 Other selected TPA milestones are: • Retrieve all SSTs 2018 • Close SSTs 2024 • Immobilize remaining tank waste 2028 • Close all tanks 2032
23 *	***Material Streams*:** ID-3857 HLW to Treatment Risk Score: 3Hanford High-Level Defense Waste. The River Protection Project (formerly known as the Tank Waste Remediation System) involves PBSs RL TW-01 through TW-09. The technical, work scope definition, and intersite dependency risks for Phase 1 Waste Treatment and Immobilization is respectively, 3,3,3 on a scale of 1 to 5 where "5" represents high programmatic risk. This stream is on the critical closure path for Hanford Site cleanup.
24	***TSD System*:** Hanford Waste Treatment and Immobilization Plant. Technical risk is timely startup of this plant and its ability to operate at planned throughput (capacity and operating efficiency).
25	***Major Contaminants*:** Fission products, actinides, nitrate
26	***Contaminated Media*:** Tank waste consisting of supernate (liquid), salt cake, and sludge. Hanford HLW is contaminated with a variety of radionuclides such as ^{90}Sr, transuranics and lanthanides. Many tanks also contain regulated inorganic and/or organic components.
27	***Volume/Size of Contaminated Media*:** The Hanford Site has 177 underground tanks that store 204 million liters (54 M gallons) of waste containing about 190 MCi of activity.
28 *	***Earliest Date Required*:** 10/2001 Rapid analytical methods will be needed during radioactive operations of the RPP-WTP, but will need to be tested and qualified in advance of production operations. Prototypic testing of the feed preparation systems, including blended feed sampling and analysis will begin in FY2002 (10/2001).
29 *	***Latest Date Required*:** 12/2009 Support Hot Commissioning (which must be completed in 12/2007) and subsequent operation leading to Commercial Operation (which must be started by 12/2009).
Baseline Technology Information	
30	***Baseline Technology/Process*:** The current baseline consists of in-lab analyses of dissolved melter feed slurries or feed slurries converted to glass. Typically acid dissolution and/or caustic fusion followed by ICP-AES or ICP-MS for metals and GEA, separation and beta counting, and alpha energy analysis for

	radionuclides. Organic analyses are also planned to take place in-lab. **Technology Insertion Point(s):** N/A
31	***Life-Cycle Cost Using Baseline*: :** The current baseline for the WTP is several billion dollars, with the BNI estimate itself is in the $4 billion range. The current River Protection Project life cycle costs are estimated at approximately $50 The current baseline for the WTP is several billion dollars, with the BNFL estimate over $20 billion. The current River Protection Project (formerly known as Tank Waste Remediation Systems) life cycle costs are estimated at approximately $50 billion. Withbillion. With exclusively in-lab analyses, processing could become a rate-limiting step. Faster analyses could greatly reduce overall processing times and operating costs.
32	***Uncertainty on Baseline Life-Cycle Cost*:** There is large uncertainty in the WTP life-cycle cost, providing the opportunity to reduce the life-cycle cost due to operation improvements as well as ensuring operational success not to add additional cost to the systemCurrently there is large uncertainty in the WTP life-cycle cost, and it will be revised after the new Design and Construction contractor is put under contract early in FY2001.
33	***Completion Date Using Baseline:*** Plant operations will be completed between 2028 and 2040.Currently there is large uncertainty in the WTP life-cycle cost, and it will be revised after the new Design and Construction contractor is put under contract early in FY2001.
Points of Contact (POC)	
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